Note : much of the hydrometric data featured in this report is provisional

Hydrological summary for the United Kingdom

November 2000

General

Floodplains form part of the natural province of rivers and, as such, are subject to periodic inundation. This fact, and its implications, have been dramatically underlined during the last 10 weeks. Heavy and sustained November rainfall provided the culmination to the wettest autumn for England and Wales in a record from 1766. The recorded range of cumulative rainfall, runoff totals, and autumn aquifer recharge rates, has been extended over a period which has witnessed flooding on a scale and duration which has few modern parallels. Most reservoir stocks are close to capacity and groundwater levels are approaching, or have exceeded, seasonal maxima over wide areas. Extensive sheets of floodwater have become a prominent, if temporary, feature of the landscape, and saturated catchments have greatly restricted farming activities; significant soil erosion has also been reported. Many catchments remain very vulnerable to relatively modest further rainfall. November has tested the resilience of existing flood alleviation strategies and sharpened the debate concerning the likely frequency of similar flood events in the future.

Rainfall

November was a mild month but remarkable for the frequency of vigorous frontal systems which assailed much of the UK. Notable rainfall accumulations were commonplace and numerous local rainfall records have been established. Linton-on-Ouse (North Yorkshire) reported 154.8 mm over the 10 days beginning on the 29th October – a period over which, nationally, the rainfall was equivalent to that normally registered over about six weeks. Thereafter, the speed of passage of the frontal systems helped to moderate storm totals somewhat. Nonetheless, apart from a few coastal locations in Scotland, November rainfall totals were above average, generally by a very wide margin. A large swathe of central and southern England again exceeded twice the monthly average. Northern Ireland had its wettest November since 1982 (boosted, locally, by a 48-hr total of 167 mm at Silent Valley on the 5-7th) whilst E&W reported its 2nd wettest November in the last 50 years. However, the autumn (Sept-Nov) totals are conspicuously more outstanding; only Nov 1929 – Jan 1930 has produced a higher 3-month rainfall total in the last 200 years. Rainfall accumulations over the period since mid-September are truly exceptional corresponding to over 60% of the annual average rainfall in many areas from the Pennines to Kent (reaching around 75% in parts of Sussex and Kent). Numerous local rainfall records have been established and with heavy rainfall continuing into December, 90-100 day totals for large parts of England and Wales may well be without recorded precedent.

Flows

Exceptional rainfall on the 29th October (many areas received > 35 mm) triggered significant flooding in catchments throughout much of the country. By early November, the severe but spatially restricted flooding of early October (in the South-East) had extended, initially to Yorkshire and then to many western catchments (the Severn Basin especially), parts of northern Britain and NI. Provisional data indicate that existing maximum flows were superseded on, for example, the Whiteadder, and the Annacloy in NI (on the 7/8th). Many rivers in E&W reported peak flows with return periods in the 5-20 year range. Recessions ensued but with catchments saturated, surface storage exhausted, and watercourses running full, even modest additional rainfall was certain to bring further inundation. Overall, the November flooding was most notable for its spatial extent and duration (embracing multiple flood events in many catchments) though some peak flows were outstanding (e.g. the Trent at Colwick registered its highest flow in a record from 1958). For around two-thirds of the index stations in E&W, November runoff totals were unprecedented (including the Lee in a 118- year record), more notably, flows were unprecedented for any month at about a sixth of the sites. Extra-ordinary rates of aquifer recharge (see below) added a further dimension in mid-November as spring-fed streams were in high spate (e.g. the Meon and Lavant in Sussex) and groundwater flooding was reported from some localities (e.g. Hambledon, Hants). Hydrometric personnel have been extremely hard-pressed and final flow figures are awaited in some areas. Nonetheless, it appears that in the last 50 years only the flooding of March 1947 (when snowmelt over frozen ground produced remarkable runoff rates) and, possibly, that experienced in December 1965 were of comparable, or greater, magnitude when considered in a national perspective. The eclipsing of some of the November peaks during December (e.g. on the Thames) signalled an additional phase in an event whose full significance awaits verification of peak flows, their analysis in a full historical context – and the termination of the flooding.

Groundwater

Following the rapid elimination of soil moisture deficits in October, infiltration over the last 8 weeks has been remarkable. Effective rainfall totals for November were more than four times the monthly average throughout many eastern aquifer units; records maintained by the Environment Agency (Thames) confirm the recharge in some eastern outcrops to be the heaviest for the autumn in a series from 1920. Over large areas infiltration totals already exceed the full winter average. Correspondingly, recoveries in groundwater levels have been very steep (in responsive major and minor aquifers alike). At West Woodyates the water-table rose 25 metres in 18 days (to the 10/11) and nearly 15 metres in 23 days (to the 19th) at Little Bucket. By the 8th, Chilgrove was overflowing having risen 30 metres since early October. Rises in the Carboniferous limestone (Alstonfield) were even more spectacular and, entering the winter, overall groundwater resources were at historically high levels.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
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Rainfall accumulations and return period estimates

Area	Rainfall	Nov 2000	Sep 00-Nov 00	RP	Jun 00-Nov 00	RP	Mar 00-Nov 00	RP	Dec 99-Nov 00	RP
England & Wales	mm	**168**	**464**		**635**		**878**		**1163**	
	%	**187**	**184**	**>>200**	**140**	**35-50**	**135**	**50-80**	**130**	**50-80**
North West	mm	235	665		946		1192		1638	
	%	191	182	>200	148	70-100	135	40-60	136	120-170
Northumbrian	mm	163	403		601		833		1102	
	%	190	171	80-120	136	25-40	132	30-45	118	35-50
Severn Trent	mm	141	384		535		763		982	
	%	199	193	>>200	141	30-45	138	50-80	130	30-45
Yorkshire	mm	161	444		628		871		1086	
	%	201	201	>>200	152	110-150	145	120-170	132	50-80
Anglian	mm	111	307		425		627		766	
	%	191	194	>>200	136	20-30	138	50-80	129	30-45
Thames	mm	130	381		497		735		930	
	%	200	205	>>200	143	30-40	144	70-100	135	40-60
Southern	mm	176	512		626		888		1126	
	%	207	219	>>200	159	120-170	158	>>200	145	>200
Wessex	mm	155	438		577		848		1131	
	%	187	187	150-250	141	25-40	143	70-100	135	50-80
South West	mm	210	571		746		1023		1454	
	%	168	171	70-100	134	10-20	128	15-25	124	10-20
Welsh	mm	246	658		915		1220		1719	
	%	173	167	70-100	141	30-50	133	30-45	131	40-60
Scotland	mm	**172**	**544**		**777**		**1057**		**1704**	
	%	**114**	**121**	**5-10**	**104**	**2-5**	**102**	**2-5**	**119**	**20-30**
Highland	mm	210	592		829		1187		2070	
	%	103	103	2-5	92	2-5	95	2-5	118	10-20
North East	mm	167	432		611		889		1230	
	%	169	153	40-60	120	5-10	124	15-25	126	40-60
Tay	mm	152	511		739		992		1550	
	%	126	140	10-20	121	5-10	115	5-10	126	30-45
Forth	mm	135	441		678		916		1399	
	%	121	131	5-10	118	5-10	114	5-10	126	35-50
Tweed	mm	151	408		648		880		1224	
	%	162	147	20-35	129	10-20	124	10-20	126	30-45
Solway	mm	207	692		982		1243		1840	
	%	144	156	40-60	133	25-40	122	10-20	129	50-80
Clyde	mm	175	679		960		1234		2044	
	%	97	123	5-10	108	2-5	102	2-5	121	15-25
Northern Ireland	mm	**154**	**444**		**638**		**852**		**1241**	
	%	**150**	**141**	**10-20**	**117**	**5-10**	**111**	**2-5**	**117**	**5-15**

RP = Return period

The monthly rainfall figures* are copyright of The Met. Office and may not be passed on to any unauthorised person or organisation. **All monthly totals since December 1998 are provisional (see page 12).** The return period estimates are based on tables provided by the Meteorological Office (see Tabony, R.C., 1977, *The variability of long duration rainfall over Great Britain*, Scientific Paper No. 37) and relate to the specified span of months only (return periods may be up to an order of magnitude less if n-month periods beginning in any month are considered); RP estimates for Northern Ireland are based on the tables for north-west England. The tables reflect rainfall over the period 1911-70 and assume a stable climate. Artifacts in the England & Wales and Scotland rainfall series can exaggerate the relative wetness of the recent past. *See page 12.

Rainfall . . . Rainfall . . . Rainfall

Key

00% Percentage of 1961-90 average

Very wet

Substantially above average

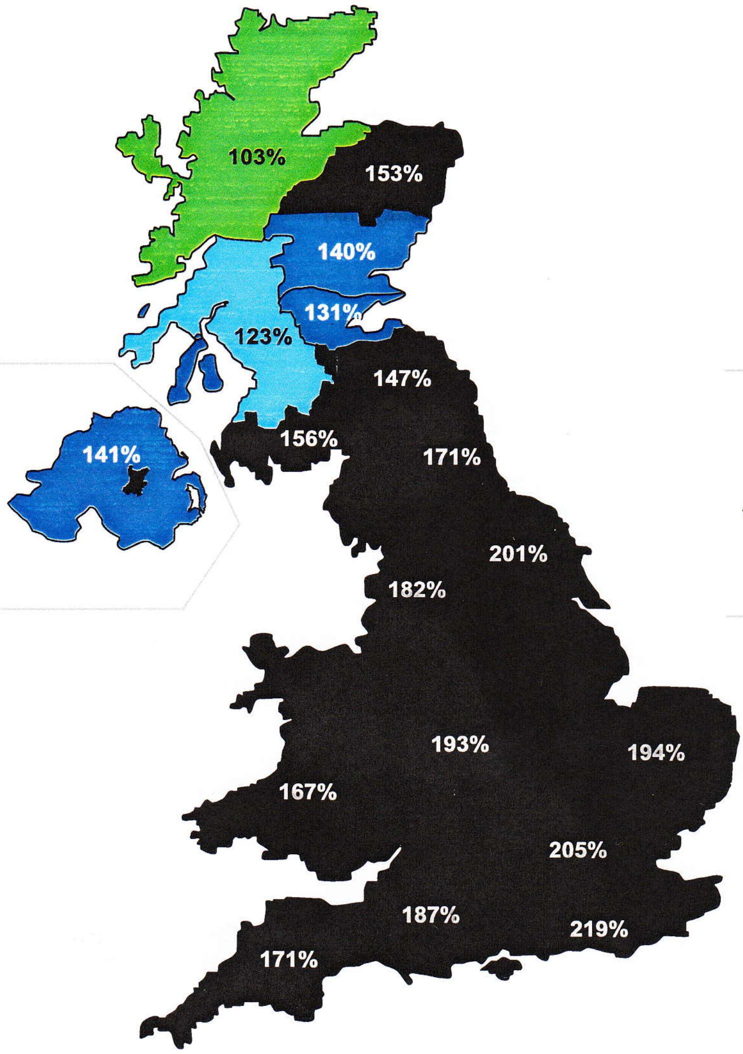
Above average

Normal range

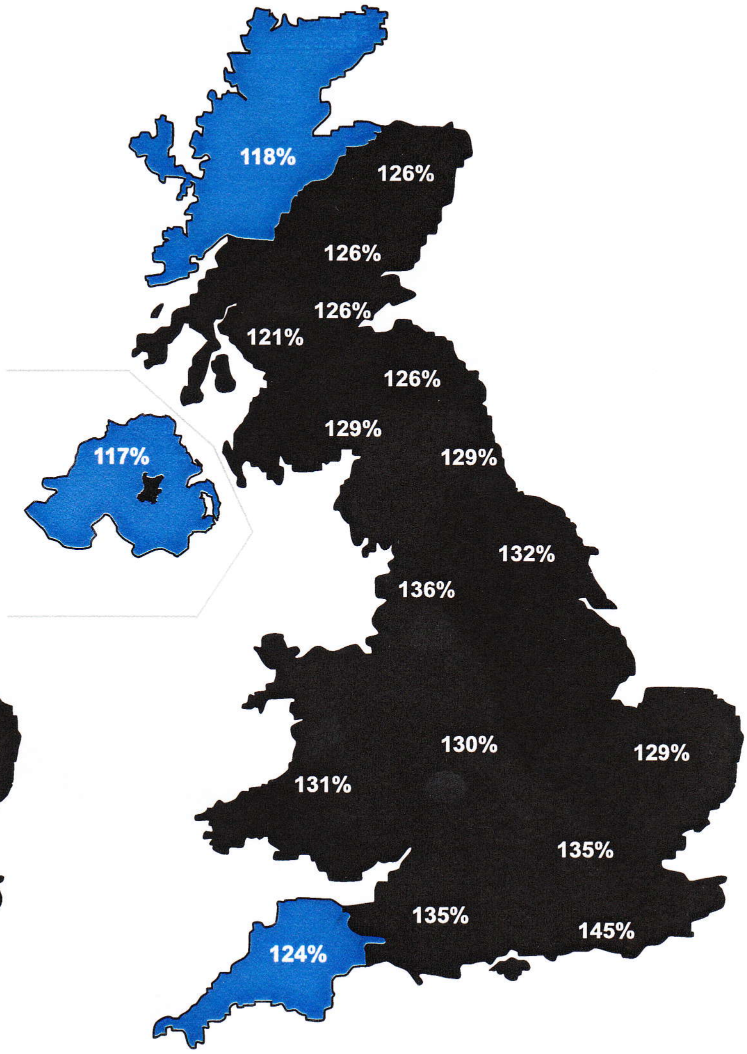
Below average

Substantially below average

Exceptionally low rainfall



September 2000 - November 2000

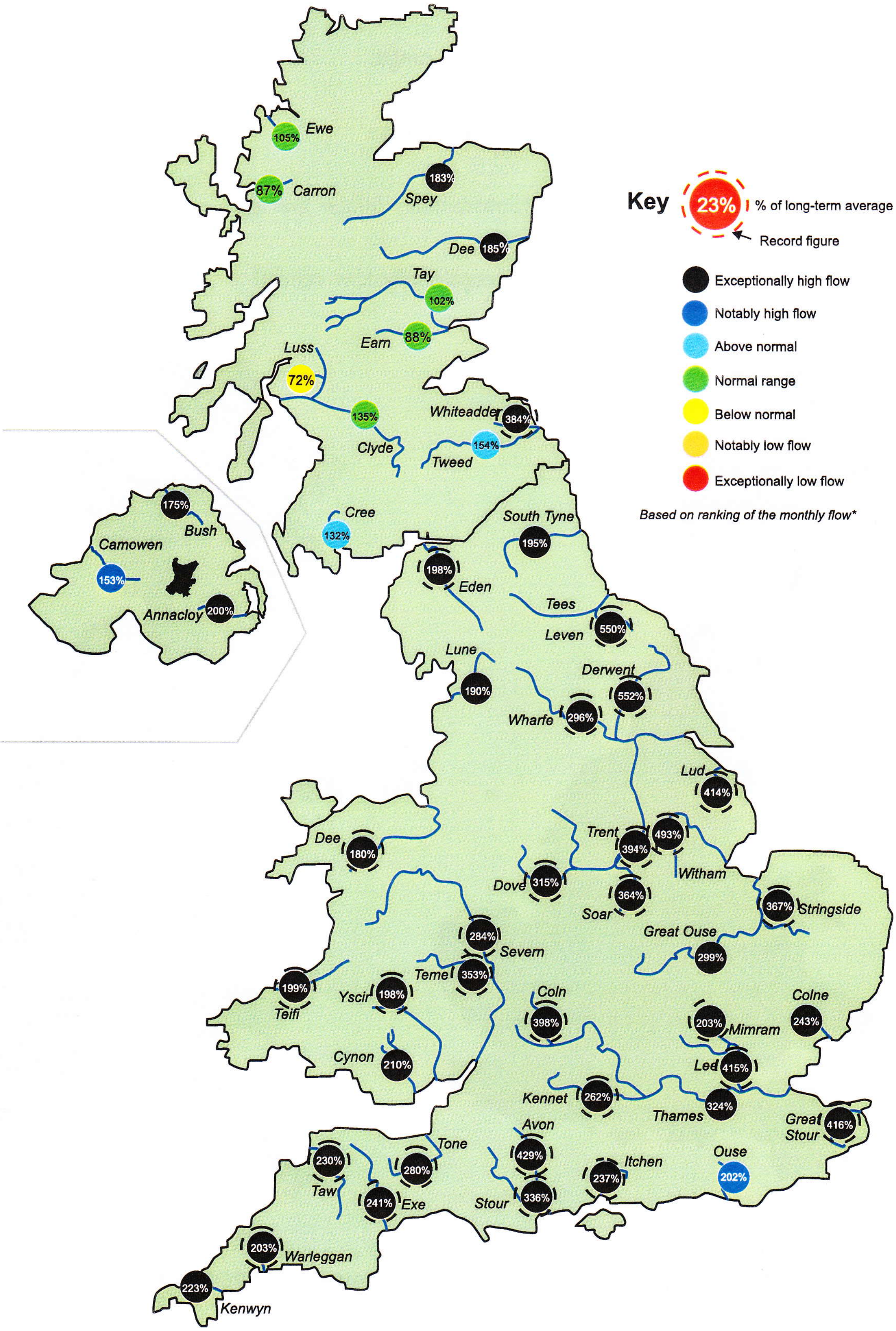


December 1999 - November 2000

Rainfall accumulation maps

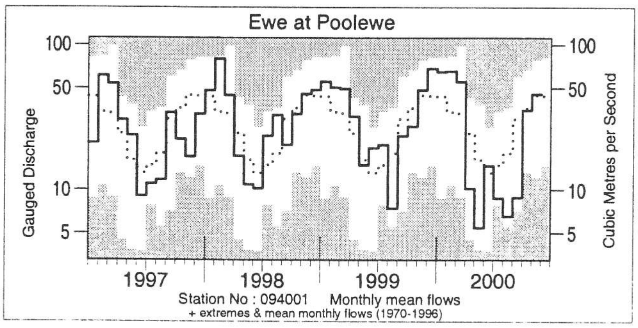
For many parts of southern and eastern Britain rainfall totals for September, October and November were each notably high (approaching or exceeding twice the average). A relatively dry September in much of the Highlands was a moderating factor in Scotland but nonetheless the autumn rainfall for the UK as a whole is the highest on record, in a series from 1900.

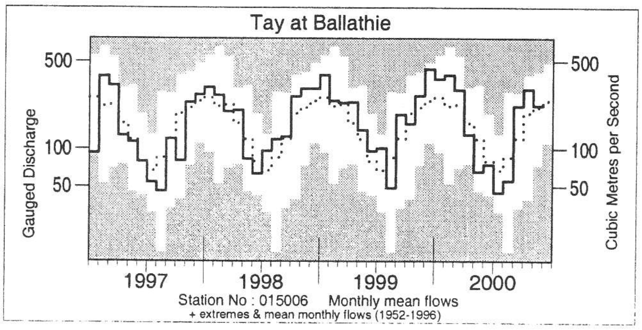
River flow . . . River flow . . .

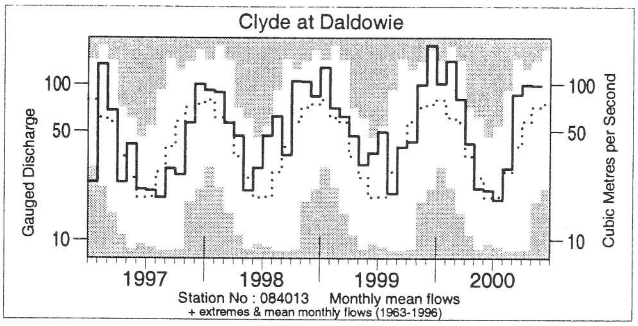


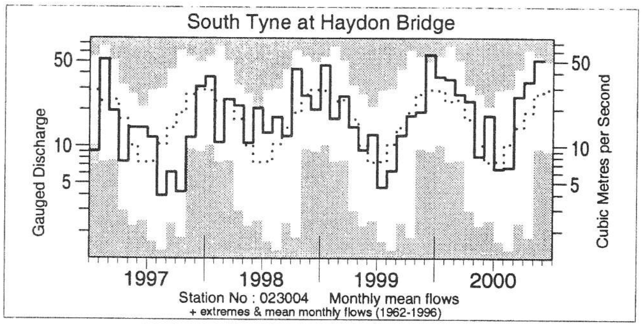
River flows - NovembOer 2000

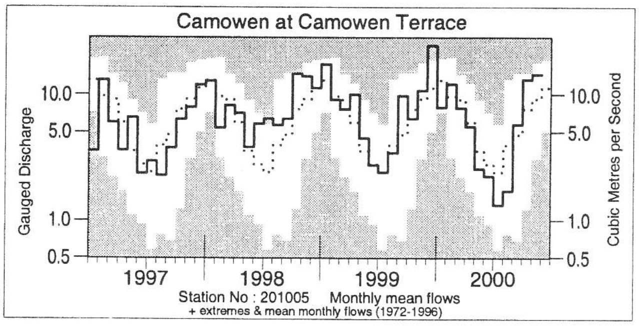
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater. Note: the period of record on which these percentages are based varies from station to station.

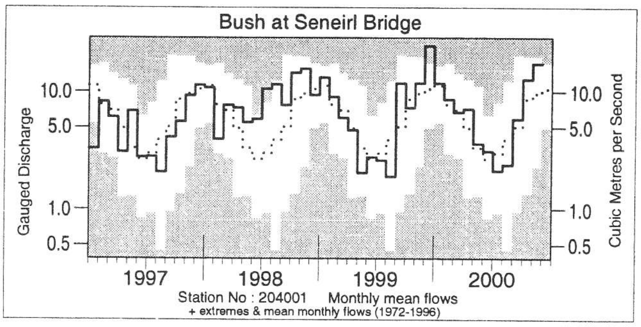


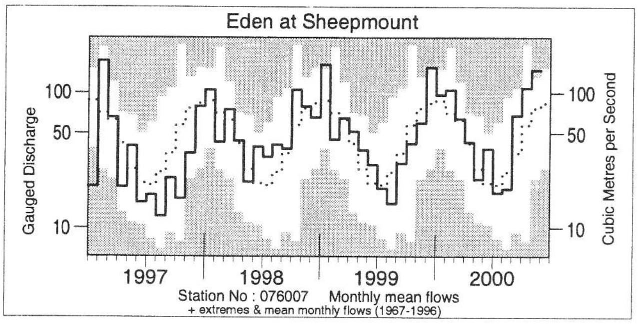


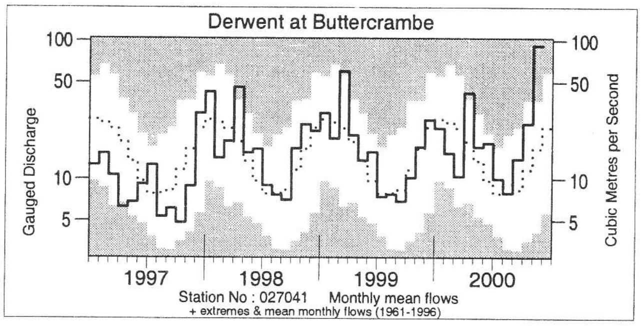


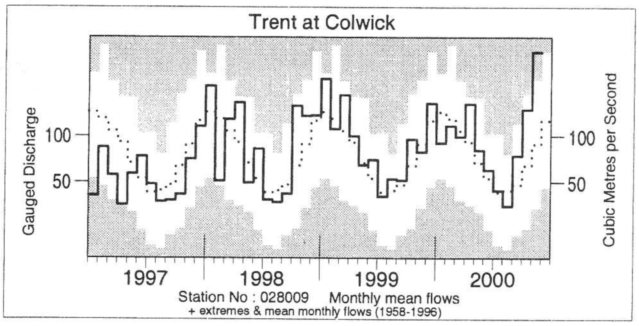


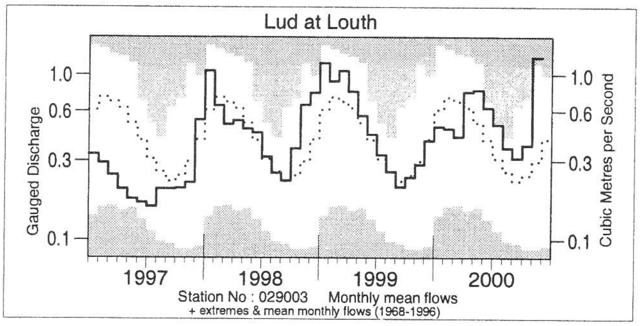








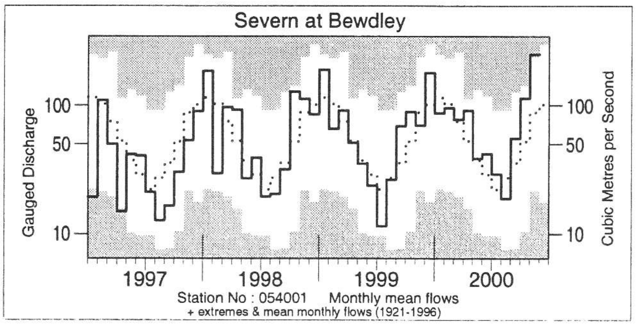


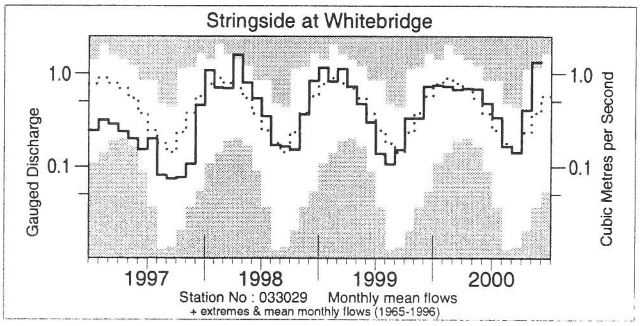


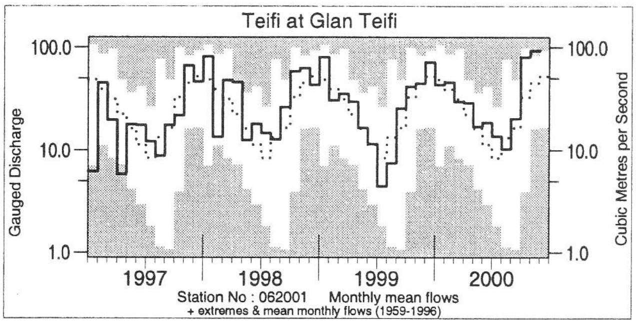
Monthly river flow hydrographs

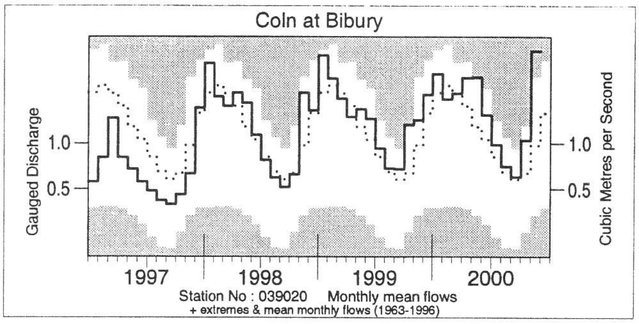
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1997 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

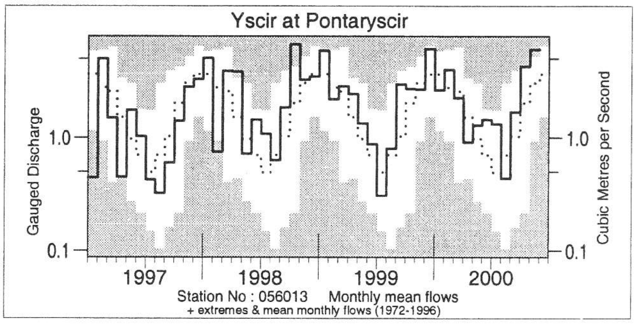
River flow . . . River flow . . .

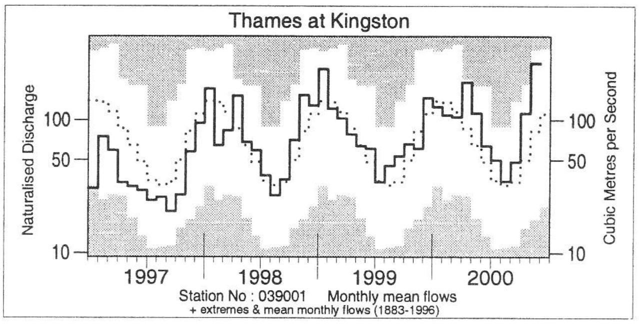


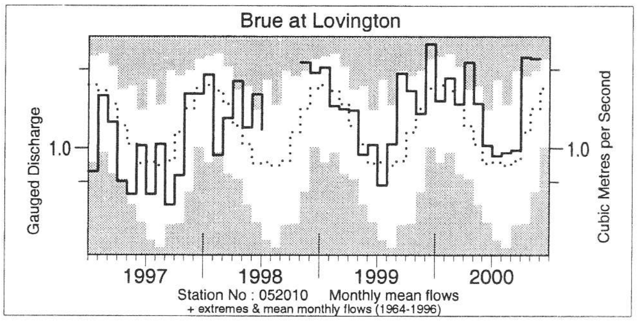


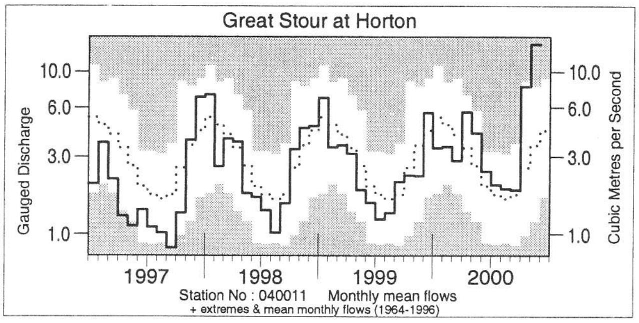


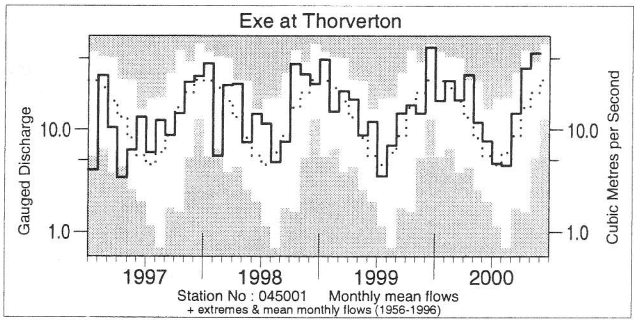


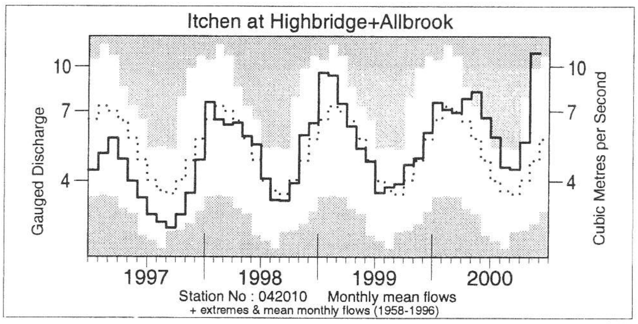










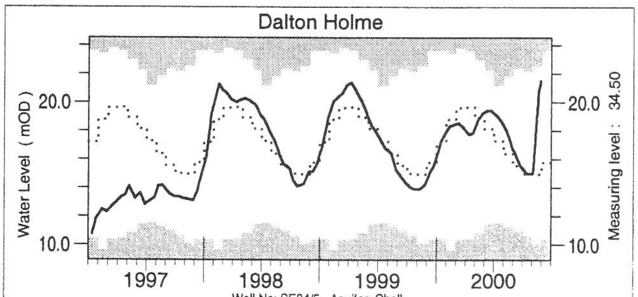


Notable runoff accumulations September - November 2000

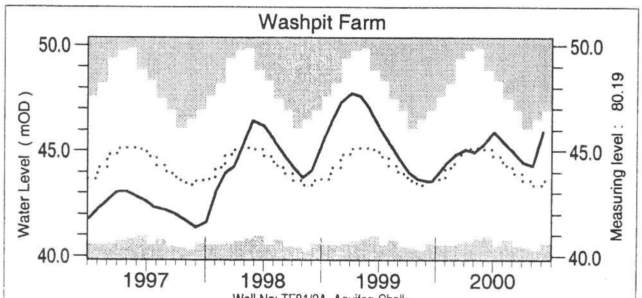
River	%lta	Rank	River	%lta	Rank	River	%lta	Rank
Wharfe	243	45/45	Medway	388	39/39	Severn	232	80/80
Dove	251	39/39	Avon	271	36/36	Dee	209	63/63
Witham	337	42/42	Exe	218	45/45	Clyde	165	37/37
Lee	328	115/115	Tone	252	40/40	Annacloy	203	21/21

lta = long term average
Rank 1 = lowest on record

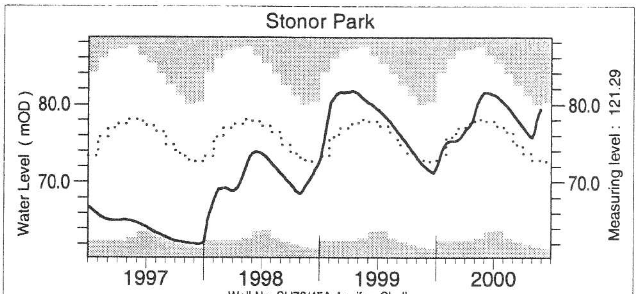
Groundwater . . . Groundwater



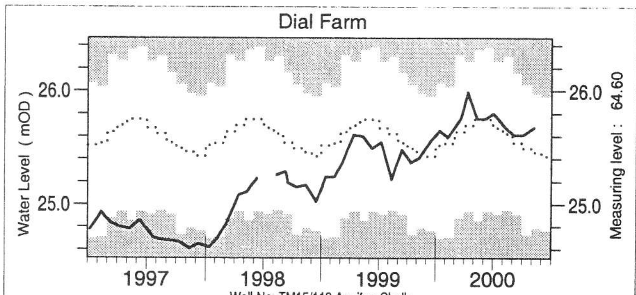
Well No: SE94/5 Aquifer: Chalk
+ extremes & mean monthly levels (1889-1996)



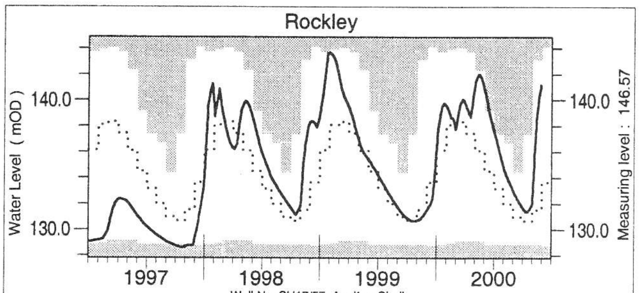
Well No: TF81/2A Aquifer: Chalk
+ extremes & mean monthly levels (1950-1996)



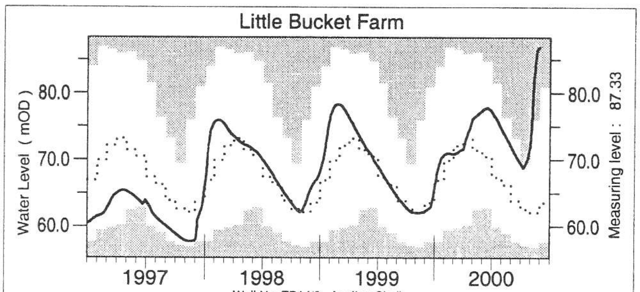
Well No: SU78/45A Aquifer: Chalk
+ extremes & mean monthly levels (1961-1996)



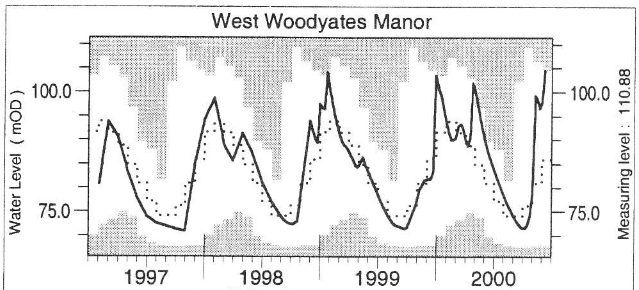
Well No: TM15/112 Aquifer: Chalk
+ extremes & mean monthly levels (1968-1996)



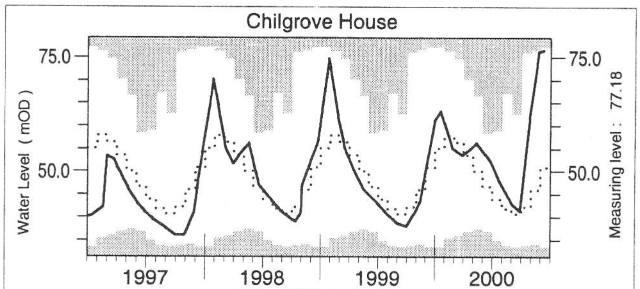
Well No: SU17/57 Aquifer: Chalk
+ extremes & mean monthly levels (1933-1996)



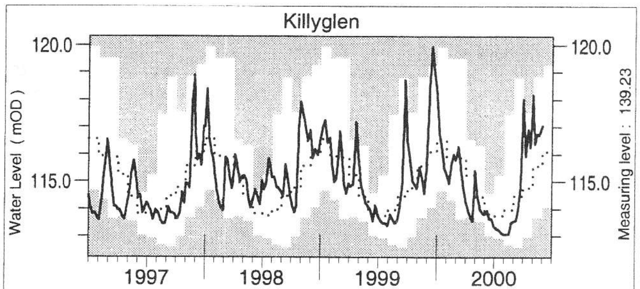
Well No: TR14/9 Aquifer: Chalk
+ extremes & mean monthly levels (1971-1996)



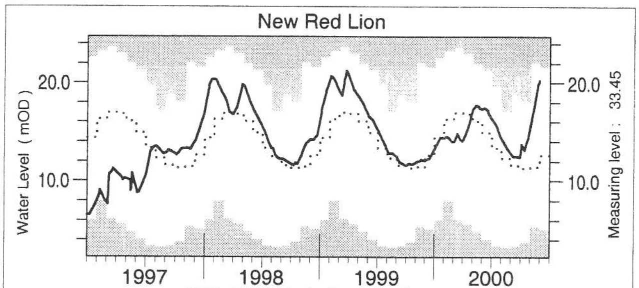
Well No: SU01/5B Aquifer: Chalk
+ extremes & mean monthly levels (1942-1996)



Well No: SU81/1 Aquifer: Chalk
+ extremes & mean monthly levels (1836-1996)



Well No: ID30/1 Aquifer: Chalk
+ extremes & mean monthly levels (1985-1996)

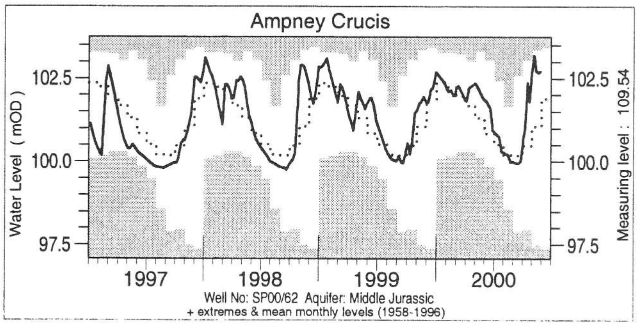


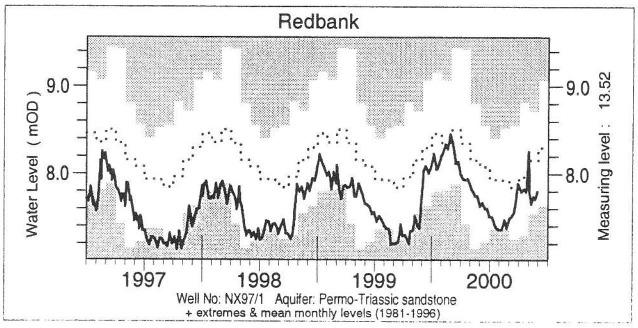
Well No: TF03/37 Aquifer: Lincolnshire Limestone
+ extremes & mean monthly levels (1964-1996)

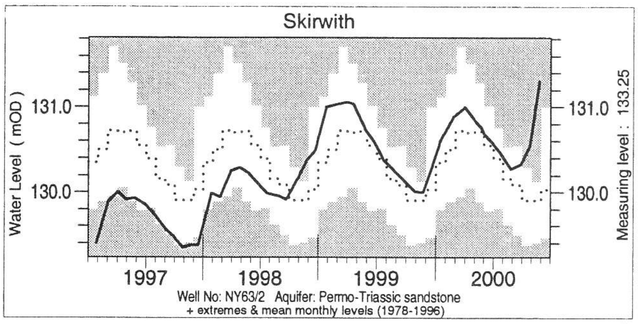
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined below overlying impermeable strata. The monthly max., min. and mean levels are displayed in a similar style to the river flow hydrographs. Note that most groundwater levels are not measured continuously — the latest recorded levels are listed overleaf.

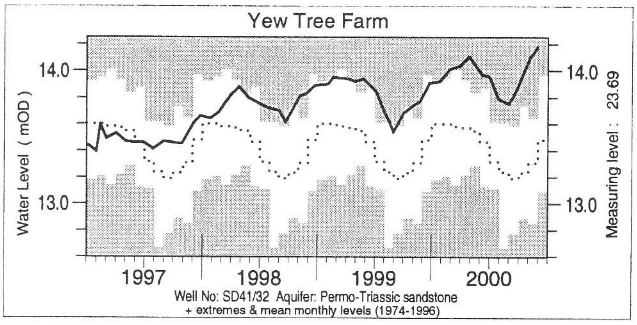
Note. Due to the impact of abstraction on groundwater levels at The Holt borehole, it has been replaced as an index site by the Stonor Park well.

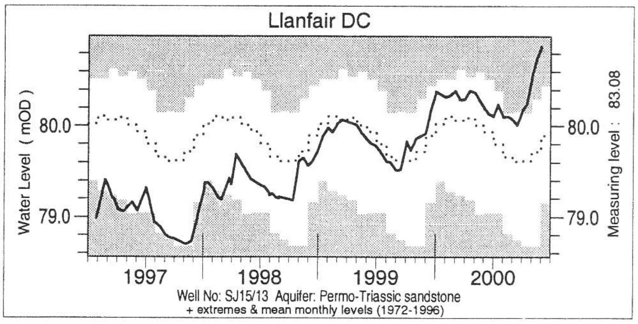
Groundwater . . . Groundwater

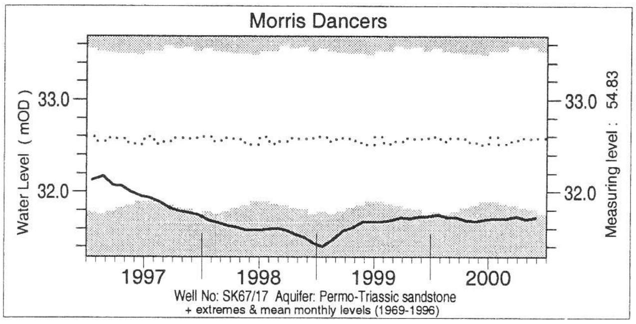


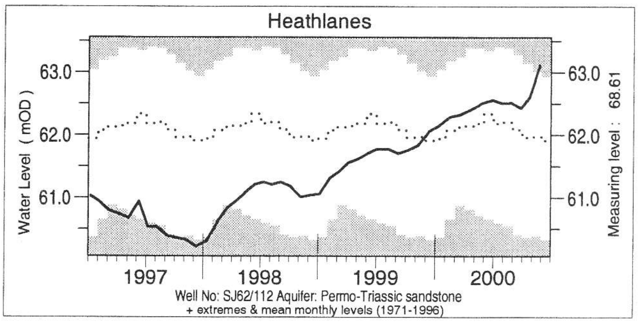


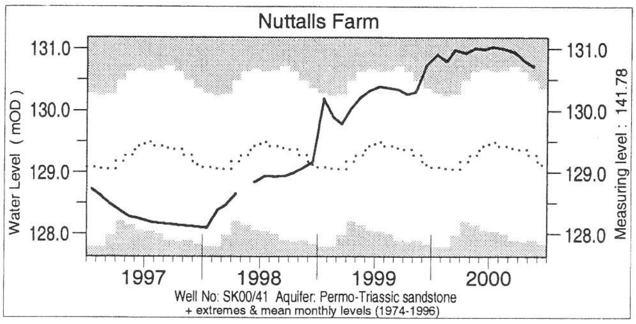


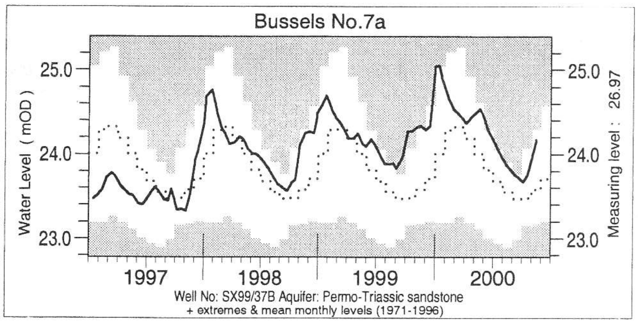


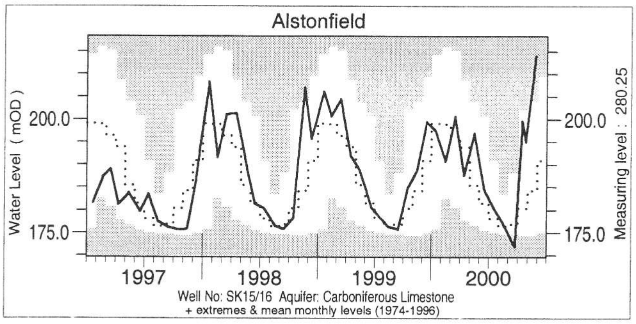












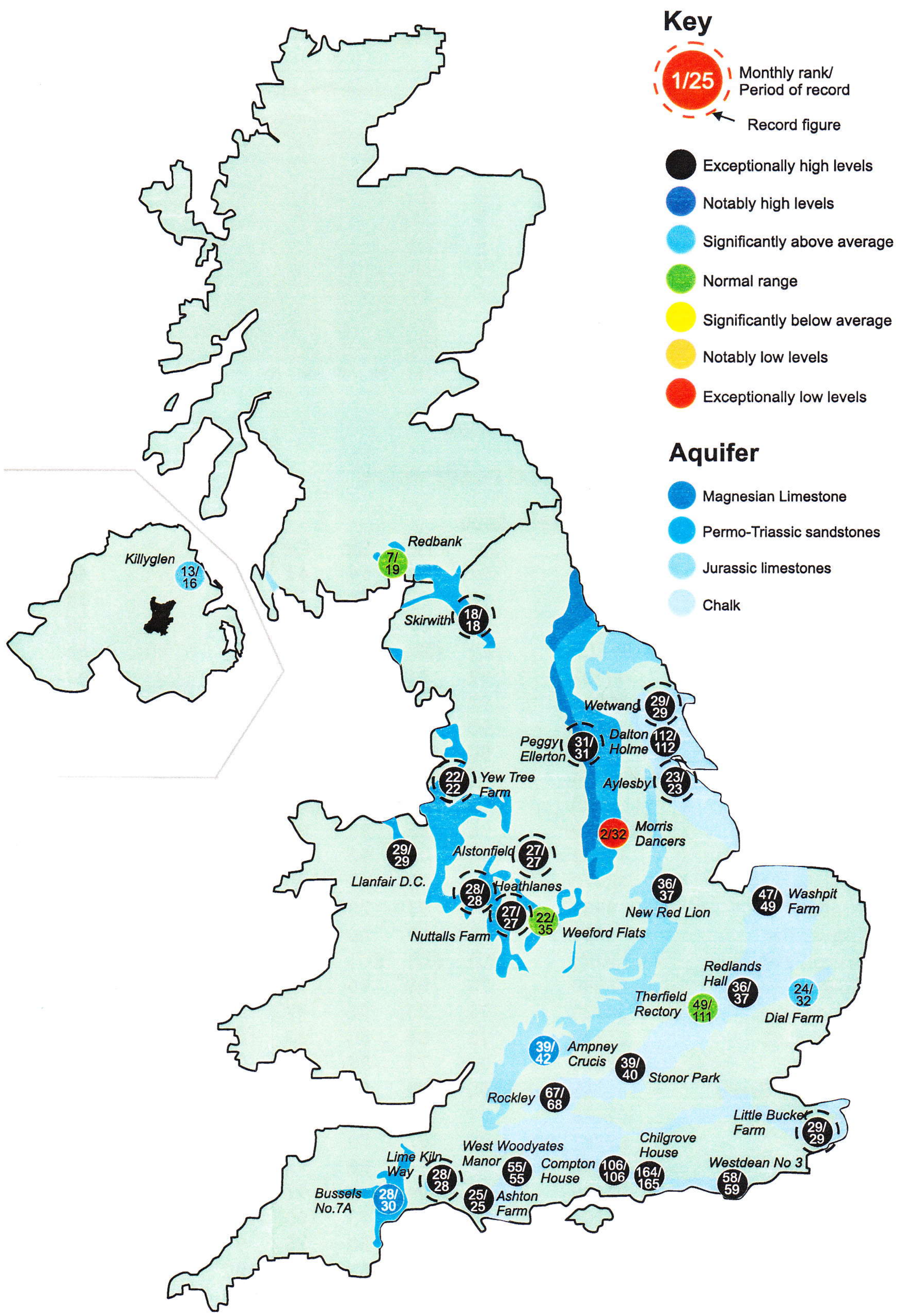
Groundwater levels November/December 2000

Borehole	Level	Date	Nov. av.
Dalton Holme	21.50	27/11	14.79
Washpit Farm	45.92	04/12	43.19
Therfield Rectory	77.40	27/11	78.20
Dial Farm	25.68	07/11	25.42
Rockley	141.19	27/11	131.50
Little Bucket	86.81	28/11	62.37
West Woodyates	104.42	08/12	80.79

Borehole	Level	Date	Nov. av.
Chilgrove	76.46	08/12	46.50
Killyglen	117.06	30/11	116.00
New Red Lion	20.27	29/11	11.72
Ampney Crucis	102.71	27/11	101.15
Redbank	7.80	28/11	8.06
Skirwith	131.30	24/11	129.88
Yew Tree Farm	14.18	29/11	13.37

Borehole	Level	Date	Nov. av.
Llanfair D.C.	80.88	01/12	79.56
Morris Dancers	31.72	27/11	32.42
Heathlanes	63.12	25/11	61.81
Nuttalls Farm	130.71	15/11	129.37
Bussels No. 7A	24.17	15/11	23.61
Alstonfield	213.99	24/11	185.20

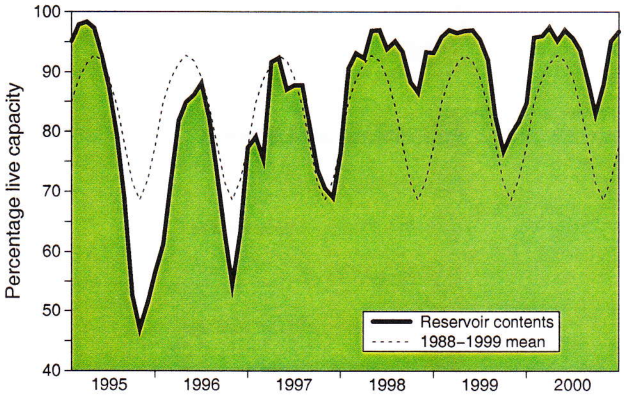
Levels in metres above Ordnance Datum



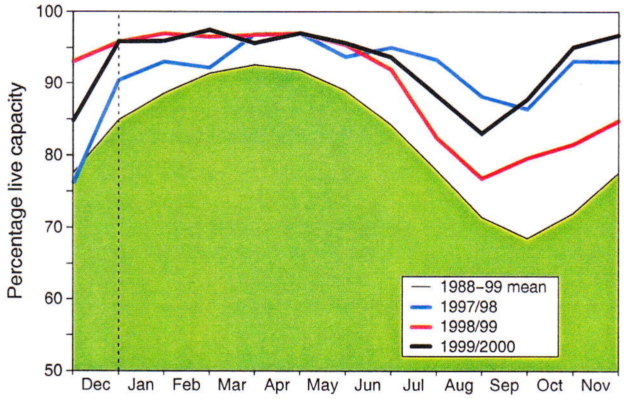
Groundwater levels - November 2000

The rankings are based on a comparison between the average level in the featured month (but often only single readings are available) and the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing wells with very different periods of record. Rankings may be omitted where they are considered misleading.

Guide to the variation in overall reservoir stocks for England and Wales



Comparison between overall reservoir stocks for England and Wales in recent years



These plots are based on the England and Wales figures listed below.

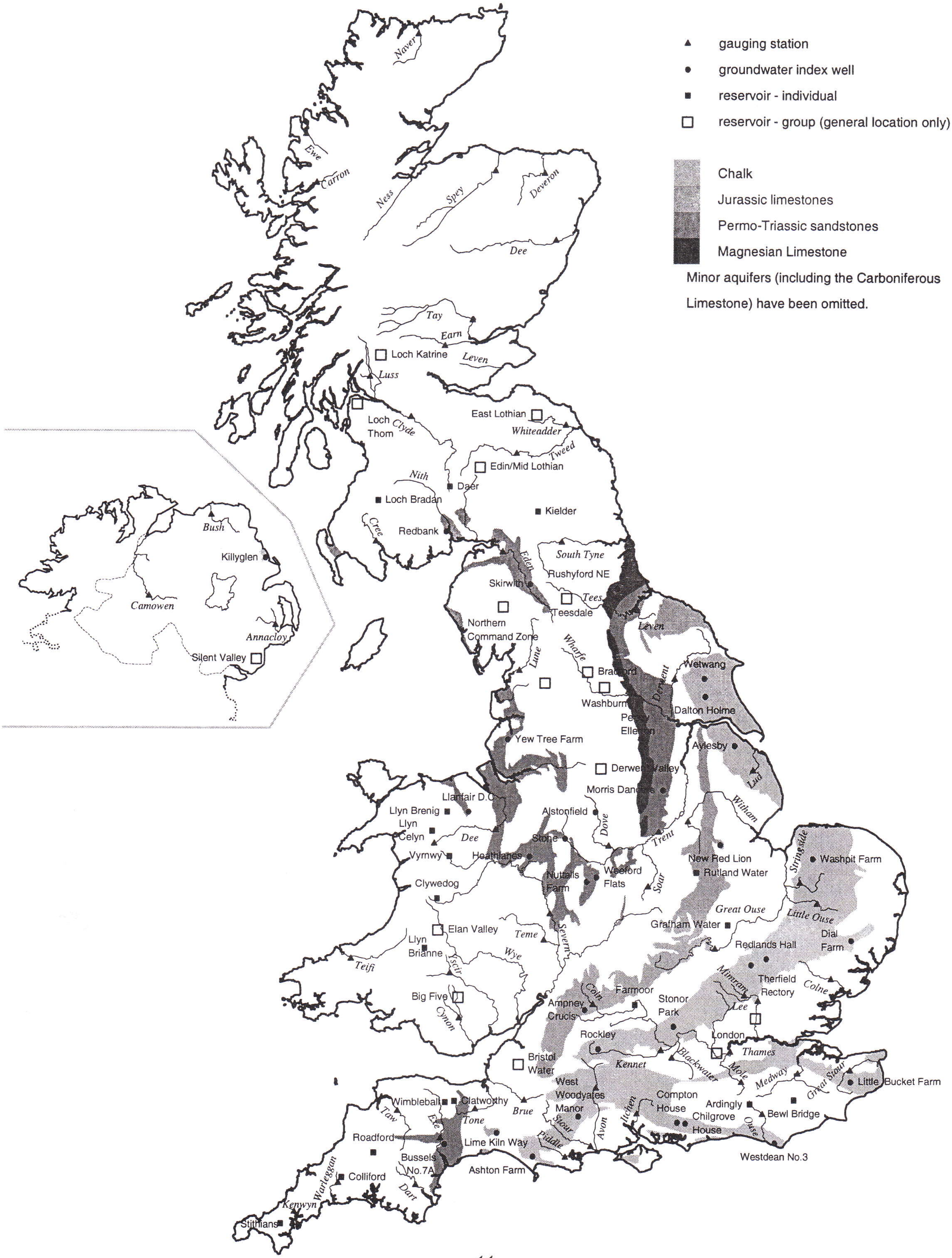
Percentage live capacity of selected reservoirs

Area	Reservoir	Capacity (Ml)	2000 Jul	Aug	Sep	Oct	Nov	Dec	Min. Dec	Year* of min
North West	N Command Zone	• 133375	77	64	54	62	78	96	44	1993
	Vyrnwy	55146	98	93	89	99	100	100	33	1995
Northumbrian	Teesdale	• 87936	93	87	78	95	99	100	39	1995
	Kielder	(199175)	(92)	(90)	(91)	(93)	(97)	(95)	65	1989
Severn Trent	Clywedog	44922	99	96	88	90	98	98	43	1995
	Derwent Valley	• 39525	92	86	75	87	100	100	9	1995
Yorkshire	Washburn	• 22035	90	83	76	85	98	97	16	1995
	Bradford supply	• 41407	90	76	67	83	99	100	20	1995
Anglian	Grafham	** (55490)	(92)	(93)	(92)	(94)	(94)	(89)	47	1997
	Rutland	**(116580)	(94)	(90)	(84)	(81)	(89)	(89)	57	1995
Thames	London	• 206399	96	88	83	88	97	98	52	1990
	Farmoor	• 13843	95	96	98	95	90	90	52	1990
Southern	Bewl	28170	100	93	85	80	89	98	34	1990
	Ardingly	4685	99	93	78	83	100	100	44	1989
Wessex	Clatworthy	5364	93	80	66	63	100	100	37	1989
	Bristol WW	• (38666)	(92)	(87)	(77)	(76)	(95)	(99)	27	1990
South West	Colliford	28540	98	95	90	92	100	100	42	1995
	Roadford	34500	96	94	92	97	100	99	19	1995
	Wimbleball	21320	96	89	80	83	100	100	34	1995
	Stithians	5205	84	74	58	56	76	100	29	1990
Welsh	Celyn and Brenig	• 131155	100	99	97	98	99	100	50	1995
	Brianne	62140	99	96	92	97	100	100	72	1995
	Big Five	• 69762	96	87	78	83	90	89	49	1990
	Elan Valley	• 99106	97	94	88	96	100	100	47	1995
East of Scotland	Edinburgh/Mid Lothian	• 97639	90	84	76	91	99	100	56	1998
	East Lothian	• 10206	96	93	93	100	100	100	43	1989
West of Scotland	Loch Katrine	• 111363	65	53	50	75	97	98	86	1997
	Daer	22412	80	66	68	98	100	100	87	1997
	Loch Thom	• 11840	69	59	60	80	100	100	82	1997
Northern Ireland	Silent Valley	• 20634	57	42	33	45	65	85	58	1999

()figures in parentheses relate to gross storage •denotes reservoir groups *last occurrence **updated gross capacity

Details of the individual reservoirs in each of the groupings listed above are available on request. The featured reservoirs may not be representative of the storage conditions across each region; this can be particularly important during droughts. The minimum storage figures relate to the 1988-2000 period only (except for West of Scotland where data commence in 1994). In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes.

Location map . . . Location map



National Hydrological Monitoring Programme

The National Hydrological Monitoring Programme was instigated in 1988 and is undertaken jointly by the Centre for Ecology and Hydrology, Wallingford (formerly the Institute of Hydrology - IH) and the British Geological Survey (BGS). Financial support for the production of the monthly Hydrological Summaries is provided by the Department of the Environment, Transport and the Regions, the Environment Agency (EA), the Scottish Environment Protection Agency (SEPA), the Rivers Agency (RA) in Northern Ireland, and the Office of Water Services (OFWAT).

Data Sources

River flow and groundwater level data are provided by the regional divisions of the EA (England and Wales) and SEPA (Scotland), data for Northern Ireland are provided by the Rivers Agency and the Department of the Environment (NI). In all cases the data are subject to revision following validation (flood and drought data in particular may be subject to significant revision).

Reservoir level information is provided by the Water Service Companies, the EA, the West of Scotland and East of Scotland Water Authorities, and the Northern Ireland Water Service.

The National River Flow Archive (maintained by CEH Wallingford) and the National Groundwater Level Archive (maintained by BGS) provide the historical perspective within which to examine contemporary hydrological conditions.

Rainfall

Most rainfall data are provided by The Met. Office (address opposite). To allow better spatial differentiation the rainfall data for Britain are presented for the regional divisions of the precursor organisations of the EA and SEPA. Following the discontinuation of The Met. Office's CARP system in July 1998, the areal rainfall figures have been derived using several procedures, including initial estimates based on MORECS*. Recent figures have been produced by The Met. Office, National Climate Information Centre (NCIC), using a technique similar to CARP. An initiative is underway with The Met. Office to provide more accurate areal figures and, since October 1999, to include more raingauges in the analysis. A significant number of additional monthly rainfall totals are currently being provided by the Environment Agencies; over the coming months further monthly raingauge totals will be included for selected regions. Until the access to these additional data has stabilised the regional figures (and the return periods associated with them) should be regarded as a guide only.

*MORECS is the generic name for the Meteorological Office services involving the routine calculation of evaporation and soil moisture throughout Great Britain.

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The National Hydrological Monitoring Programme depends on the active cooperation of many data suppliers. This cooperation is gratefully acknowledged; the Hydrological Summaries for the autumn of 2000, in particular, stand as a testimony to the assistance provided by many hydrometric personnel working in exceptionally challenging circumstances.

Subscription

Subscription to the Hydrological Summaries costs £48 per year. Orders should be addressed to:

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Selected text and maps are available on the WWW at http://www.nwl.ac.uk/ih

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